Q-arrgh! — Commandeering Everyday Digital Codes

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ABSTRACT
Digital markers such as barcodes and QR codes are ubiquitous. However, these codes are normally used only for retrieving a small amount of information, such as a product identifier or a web link. Much previous work has investigated the value of associating digital content with physical objects in everyday scenarios, but has so far relied primarily on adding new markers to existing items, or studied only short-term usage. In this paper, we explore the benefits of "commandeering" existing object labels to support this interaction. We add a social layer to existing digital codes, allowing users to "tag" any marker in their environment with their own messages, which can then be viewed by any other user. The core contribution of this work is the findings and insights that were collected in user studies. We explored the use of our design via two deployments that demonstrate the potential of such a system beyond its playful starting point. We conclude the work by drawing out a number of key design elements for future appropriation designs.

Author Keywords
Appropriation; tagging; barcodes; QR codes.

ACM Classification Keywords
H.5.2 User Interfaces: Interaction styles

INTRODUCTION
There is a considerable amount of research and commercial interest in the future of object tagging. Part of this is driving towards a hoped-for "Internet of Things," where everything we use is connected together and works in harmony. In the rush to further these futuristic methods of digitisation, however, we feel that the pervasive tags that already surround us are being slightly overlooked. Digital markers—barcodes and, to a lesser extent, QR-codes—are ubiquitous. However, the interactions that these markers support are, in our view, not particularly rich: as everyday consumers, at best we use them for self-service checkout machines, links to web content, or to surreptitiously compare an in-store price via a mobile app. The uses for these codes are currently rather unimaginative, then, and there are few situations in which they are used for anything other than an intended purpose. This is in stark contrast to other areas of life, where appropriation is prominent, and designers know that their products or services will often be used in ways they couldn't possibly imagine at the time of creation.

In this paper we explore the benefits of digital-physical appropriation, "commandeering" these commonplace codes and repurposing them to provide additional functionality. Our aim in this work is to make the user experience of markup codes, and the objects they are attached to, more rich – to appropriate, subvert and disrupt their mundane,"transactional" purposes.

Previous research has largely concentrated on adding new markers or tags to objects (e.g., [6, 8, 14]), rather than on improving the interactions that they already afford. Instead of modifying objects or markers, in this work we developed a simple mobile application that allows people to "tag" any object; that is, to leave digital messages on any code they find. Related work has explored tagging in this way in a retail context (e.g., [7]). The core contribution of this work, then, is the findings and insights that were collected in user studies. Our cloud-based design allows users to see messages already tagged to any scannable item, and also add their own content. Other users of the app scanning the same code see this content when it is added—the same barcode or QR code is on every instance of a product or poster—and can filter by various factors such as location, rating or time.

In the rest of this paper we discuss related work, describe two evaluations of the concept that show its benefits, then conclude with a number of interesting observations and design insights that will influence future work in this area.

BACKGROUND
People are adept at finding unexpected affordances in everyday physical objects. For example, consider how a heavy book can be both read and appropriated for other tasks, such as pressing flowers or holding a door open. Physical objects can also be marked-up easily – think of the simplicity of sticking posters on lampposts to plead for help finding a missing pet; the way in which "official notices only" boards quickly fill up with other items; or, how a secluded wall becomes a blank canvas for a graffiti artist. Digitally, however, such freeform appropriation is rarer. Permissive licenses such Creative Commons and the like show a desire to let people adapt and remix others' content, but restrictions on sharing (e.g., DRM) show push-back. So, while HCI researchers have proposed designing specifically for appropriation (e.g., [2]), creating digital solutions that embrace this is more complex than it might first appear.

One early example of digital infrastructure reuse is the toy barcode scanners, popular in Japan in the early 1990s, that gave in-game power by scanning barcoded cards (e.g., Barcode Battler[1]). Perhaps the most common recent reuse of marker

codes is to use a mobile app to scan and search for cheaper prices online (e.g., RedLaser[1]). These apps often include areas where consumers can leave reviews about a product.

Turning to research approaches, one of the earliest studies of adding digital content to physical objects was WebStickers [9], where printed sticky notes were used as physical access token for web bookmarks. Similarly, the Cooltown project [8] used beacons attached to people, places and things to give them a web presence. O'Hara et al. [11] took a related approach, but investigated how collecting content from codes around a public zoo could add to the physical experience. A human-communication take on the Internet of Things has previously been explored by both MyState [5], which allowed users to associate messages with NFC tags; and, the TOTeM project (e.g., [6]), where second-hand goods had QR codes and RFID tags attached to them to promote sharing of object histories.

All of these approaches have involved custom-made tags rather than appropriation of existing markers. In some cases this has been to limit the places in which the system is used; for others it is due to the technology involved (e.g., NFC/RFID tags). More closely related to our work are approaches such as PlaceTagz [13], StallTalk [4] and the now defunct startup Stickybits, which have all explored physical noticeboards and ad-hoc discussion points around QR and barcodes. While these previous systems have in some cases allowed users to scan existing codes, their primary focus has been on tags placed by the user themselves, in order to focus user content around a single location or object.

More similar to our work, we would argue, are approaches such as Wood et al. [15]'s Department of Hidden Stories, which linked digital tales to physical books by scanning ISBN barcodes, or Budde and Michahelles [1]'s Product Empire, which gamified scanning of product barcodes (but used the action to build up a product database, rather than to add social interaction). Finally, commercial augmented reality applications such as Layar,[3] Aurasma[4] or Blippar[5] allow any object to be tagged with digital content, but recognition relies on objects being visually alike, and there is no way to visibly tell *which* objects are marked-up. In contrast, our approach turns any scannable digital marker code into an ad-hoc public noticeboard, in a similar way to Espinoza et al.'s GeoNotes [3], but by associating notes with an object, rather than a location. In effect, our technique creates a low-end people-powered Internet of Things, with publicly-accessible and filterable message stores associated with any coded object.

Q-ARRGH!

We created a simple Android application—Q-arrgh!—to test the code appropriation concept. Taking a playful approach, we used a theme that encourages users to "commandeer" codes and attach their own content for others to discover. Once a code has been scanned, users can view existing messages tagged to the item, and filter by date, location or rating (see Fig. 1). The original content of the code is shown where relevant. Any user can add messages to any item, and existing messages can

[1]See: ondersetgonas.com/warcode; [2] See: redlaser.com
[3]See: layar.com; [4]See: aurasma.com; [5]See: blippar.com

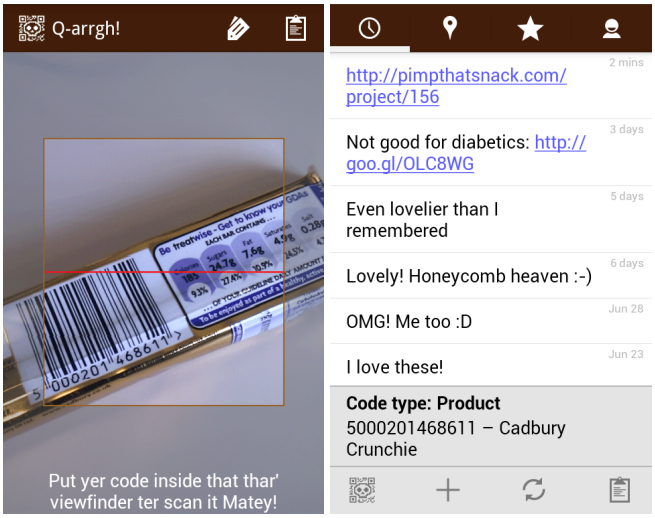

Figure 1. Q-arrgh! interface. Left: scan any code to view. Right: existing messages tagged to this object can be filtered by date, location, rating or user. Any user can add to any item. Download from: goo.gl/ki6t6v

be "liked" to increase their prominence when sorted by rating. Users can also choose to view only those messages placed on objects of this type in the nearby vicinity (e.g., "messages from people near me"), helping with filtering and relevance were the system to become popular. Messages that users add to codes are managed using the Google Cloud Platform.

We purposely do not distinguish between multiple instances of the same scanned code. Barcodes vary over product variants and sale regions, helping to automatically address more local groups of users than might be found in other services. When a code is scanned, its content is hashed – identical codes lead to the same hash, and so to the same tagged content. Message content is only visible when scanning an object's code, so users must be in possession of the object to view its messages.

We do not claim high novelty of the application, as there have been other examples of similar approaches (e.g., [7]). However, previous studies have not surfaced the value and appropriateness for such a framework in longitudinal or community-based naturalistic settings.

DEPLOYMENTS

We conducted two studies to explore the benefits of digital code appropriation. In the first, 20 participants were given an incentive to take part, using the application in their own time over a three-week period. The second deployment was in a more naturalistic setting, where users independently chose to download and use the app in a tourism context.

DEPLOYMENT 1: Q-ARRGH! FIELD STUDY

We recruited 20 participants (aged 18–65, 14M: 6F) to take part in a three-week trial of the Q-arrgh! app. Campus-based university staff and students were specifically recruited to ensure that they regularly spent time in the same specific geographical area with a common collection of codes available.

At the start of the study, participants were given an overview of the app and informed consent, then completed a questionnaire

about their current usage of barcodes and QR codes. The Q-arrgh! app was then installed on participants' own phones, and they were asked to make as much or little use of the tagging facility as they wished (participants were explicitly informed that their incentive was not dependent on them posting or interacting with messages). During the study period we monitored the use of the system for inappropriate comments, but did not need to intervene at any point. After the study, participants were interviewed about their experiences using the app, asked to rate the experience on four separate factors, and completed the same code usage questionnaire as before the trial. A £20 gift voucher was given as a token of our appreciation.

Deployment 1 results

369 unique Q-arrgh! messages were posted during the three-week deployment, primarily attached to barcodes (rather than QR codes). Twelve users who were not part of the study discovered the app on the Google Play store; these users generated 27 of the total number of messages. An average of 17 messages were posted per study participant (median 13).

Tagged messages

A variety of different use-cases emerged in the messages posted by participants. For example, many users attempted to provoke others into using the system as an ad-hoc forum, tagging objects with questions such as: *"Should the uni use this for timetable management?"* or *"Would be good to know if this ready meal works well for type 2 diabetics. What other dishes would also be good?"* Others used it as a method of advertising (e.g., *"Argus Monday July 29th 2013"*) or for joke-like comments (e.g., *"Cardboard packaging that the bleedin' bin man wouldn't take!"*).

One predictably popular category of tags involved tips or review-like comments about the product or item – for example, *"Great handcream, but takes ages to absorb. Don't use this if you need your hands for anything else in the next 10 minutes,"* and *"This label is a good example of misleading people while giving them all the facts. See if you can figure out how many calories are in this!"* Finally, there was a tendency for some users to post generic statements about what the coded item was – for example: *"Heavy duty fabric plasters. Exactly what it says on the tin," "Kodak printer baby!"* and *"Coca cola."*

Feedback and behaviours

Table 1 shows participants' responses to ratings of four aspects of the system. The majority of participants felt that using the system was interesting (Q1; 19 out of 20 rated positively). Furthermore, 15 participants felt that the app was particularly useful for sharing and finding information (Q3).

Only eight participants in the study reported seeing messages left by other users, which is the cause of the lower ratings given for content engagement (Q4). This lack of other content to engage with often occurs with crowd-sourced systems that have not yet reached critical mass. Many participants commented in the closing interview that the system would be more useful if there was a larger user base, and the majority could see the potential of such a system if it became popular.

How interesting it was scanning and viewing code tags	5.4 (0.9)
How often you added tags to codes	5.8 (1.6)
How useful the app is for sharing and finding information	5.3 (1.3)
How engaging you found the content attached to codes	4.4 (1.4)

Table 1. User ratings given for the Q-arrgh! system. Participants rated each statement on a 1–7 (7 high) Likert-like scale. Standard deviations are shown in parentheses. All 20 participants answered questions 1–3; the eight who saw other participants' messages answered question 4.

One of the most interesting results from this initial study was the change in participants' attitudes towards digital marker codes. Prior to the study, 35 % of participants had never scanned a QR code before, with a further 35 % scanning very rarely (around once per year). The use of barcodes was similar, with 45 % of participants having never scanned one. Only 45 % of participants found the existing information on codes to be useful. While using the Q-arrgh! app during the study clearly influenced participants' usage of these codes, when asked in the post-study interview how using the application had changed their opinion of the codes, 18 of 20 participants (90 %) stated that they felt the codes were now more exciting or interesting than before. For example, one participant said: *"They are more interactive now. it does definitely make them more worthwhile,"* and another added *"I was amazed at the prevalence of them [digital codes]."* All participants said that they would scan more QR codes in future, and 19 (95 %) asked to keep the app to continue using it after the study.

Deployment 1 observations and discussion

The types of messages posted by participants show the range of different use-cases for commandeered digital codes. Participants appropriated markers for various purposes from ad-hoc message boards to anchors for reviews. While previous systems in this area have focused on a single content area—primarily product reviews—there are clear opportunities for appropriating digital codes in more flexible, user-led scenarios.

As is commonly observed in social media, many members of online communities prefer to remain in the background, consuming content but not actively participating themselves. It was clear that this behaviour was being demonstrated to a certain extent by several participants in this study. These users tended to scan a large number of codes, but made fewer comments in comparison to other participants. When interviewed, all of the participants who had behaved in this way also stated that any messages they did leave were more for themselves (i.e., as reminders or notes) as opposed to for other users. The majority of participants embraced the system, however, and made comments every time they scanned a code.

One unexpected usage for the system was to simply describe the item that had been scanned. We assume that in an unincentivised setting, where users were not taking part in a study, these types of message would be less prominent, or perhaps voted down by other users of the system. However, although we received comments from users regarding the current lack of messages, it would be interesting to consider how to deal with potentially large numbers of these less-useful messages if this type of system did ever reach critical mass (some possible solutions are discussed in, e.g., [3]).

DEPLOYMENT 2: MONMOUTHPEDIA INTEGRATION

The second phase of our evaluation was a wider longitudinal investigation aimed at uncovering more naturalistic tagging behaviours. Monmouth is a small town in South Wales which is the focus of MonmouthpediA – a collaborative Wikipedia-backed project that uses QRPedia codes to deliver multilingual access to online content relating to interesting features around the town. Many of the buildings in Monmouth are labelled with QR codes that link to Wikipedia articles. Visitors to the town can also take QR-based tours that lead them on specific routes and near notable QR-marked buildings. For example, the "Heritage Trail" leads visitors through archaeological sites, and the "Food Mile" helps discover some of the best local food in the area. Residents and tourists of Monmouth are exposed to a higher than normal number of QR codes, then, making it an ideal area to investigate the code commandeering approach.

We created a MonmouthpediA-branded version of the system, titled MonTag, for deployment within the town. Instead of directly recruiting participants for a set time period, we chose to allow people to download and use it at their leisure, in order to observe more natural usage. We partnered with Monmouth Town Council to advertise the app via posters in the tourist information centre, and deployed the app directly to four local residents who were keen to extend the reach of the MonmouthpediA project. To gather feedback from the anonymous participants, we included a simple 2-question in-app survey that appeared once a user had scanned four codes.

While we were of course aiming for high uptake of the MonTag system within the town, we anticipated that this was unlikely, particularly given that a large proportion of MonmouthpediA's regular users are tourists who may only be visiting for a short time. Nevertheless, we felt that with a small number of resident regular users adding local up-to-date content to tags, and curious tourists viewing and adding their own content as they used existing QRPedia tags, we would gain an insight into how the system might be used if it were to be widely adopted.

Deployment 2 results

At the time of writing, over the five months that the system has been in place, 39 unique users have posted 422 messages on MonmouthpediA QR codes around the town. In this second deployment, QR codes attached to buildings were (predictably) the most commonly tagged objects.

Tagged messages

The types of messages posted in this more naturalistic setting were very different to those observed during the first deployment. Typical MonTag messages included graffiti-style comments such as: *"Oldest theatre in Wales, to be graced by Blofield + Baxter on 7/9/13. TMS giants!"* or informative messages such as *"Given to the people of Monmouth to celebrate the golden jubilee of Queen Victoria. The latest royal milestone sees the now library thriving."* This genre of messages is clearly quite different from the more playful and joke-like content added in the first study.

MonTag users also added web-links, which was uncommon for Q-arrgh! users. For example, links to similar QRPedia articles (e.g., en.qrwp.org/The_Angel_Hotel,_Monmouth), maps, and user-created short URLs were all posted during the study.

Thirteen users completed the in app survey, rating two aspects of the system on a 1–7 (7 high) Likert-like scale. The average rating for the question: "To what extent does being able to add messages to codes add to the overall MonmouthpediA QR experience?" was 5.6 (s.d. 2.2), whereas "To what extent did the messages left by others enhance your MonmouthpediA QR experience" was given an average score of 5.0 (s.d. 2.1).

Deployment 2 observations and discussion

In our first deployment, messages tagged to codes tended to be focused around opinions, jokes and, quite often, simply stating what the code was attached to. In this second trial of the code commandeering concept, we observed far more meaningful content—such as historical information about buildings, or links to other resources—being associated with codes. This is an interesting observation, particularly when considering Seeburger [13]'s findings that only a small proportion of their system's messages related to the space around the code that was scanned. One potential reason for this may be the permanence and existing association of MonmouthpediA QR codes with digital content. Furthermore, there are ongoing discussions within the MonmouthpediA (and the wider Wikipedia community) about notability requirements that are enforced when adding content about only locally-relevant items. This may have spurred MonTag users—particularly those local to the area—to use the system's messages for adding their own additions and interpretations to items using MonTag, rather than the existing information sites.

CONCLUSIONS AND FUTURE WORK

Digital marker codes are ubiquitous, and—in certain regions—are being used by the general public more than ever before [10]. Despite their ubiquity, however, barcodes and QR codes still have rather limited additional uses beyond their intended purpose. Our approach was to add new value to existing markers, repurposing codes as message anchors to enrich the everyday interactions we already have with them.

The motivation behind commandeering this well-established infrastructure, rather than creating new tags, was two-fold:

Value: Participants in our first trial thought very little of barcodes or QR codes before the study. After using the Q-arrgh! app for three weeks, 90 % said they felt these codes were now more exciting or interesting than before. There are huge numbers of barcodes and QR codes on items we already use or purchase regularly, so adding new value to the codes already printed upon these objects may be a new way to engage users with everyday products.

Simplicity: By appropriating such widely used markers, we were able to deploy an instantly global object commandeering concept with far less cost and effort than had we chosen to deploy custom markers. Furthermore, although we observed a lack of focused user content during the trials (i.e., users not seeing others' messages), the availability of barcodes or QR codes to scan was never an issue.

One issue with creating a new network of crowdsourced content is the lack of critical content mass early in deployment. While this is not a large problem for local deployments (such as MonTag), this is likely to limit the impact of a larger appropriation agenda. Straightforward solutions to this issue could be to integrate tagging functionality into existing barcode scanner apps, or to use public services such as Twitter to host comments for tagged items.

As we have seen throughout this research, whether they are used by the general public or not, marker codes are ubiquitous, yet mundane and unappealing. Previously, we have investigated how codes can be reused to facilitate indoor navigation (see: [12]); in this work we have explored commandeering commonplace markers to provide additional functionality associated with the objects themselves. While the powerful Internet of Things agenda is driving for new methods of interacting with the world, we suggest that it may be worth first looking at existing infrastructure in new ways. For example, while we chose to use codes specifically designed for transferring encoded digital information, there are many other marks and tags (e.g., URLs) that could be commandeered in similar ways.

Finally, part of the reason we have been able to appropriate existing markers is that they are visible and open. Many of the next generation of tags and digital marked-up objects are invisible, and often proprietary (e.g., NFC/RFID/iBeacon). While this can bring size benefits and design flexibility, it inherently limits the possibility for future appropriation designs such as ours. We suggest that future designs strive for the openness and flexibility of the current digital code infrastructure, enabling others to design for appropriation as we have been able to.

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